U.S. ENVIRONMENTAL PROTECTION AGENCY
ENERGY STAR Office Equipment Program (MC: 6202J)
Washington, DC 20460
(888) STAR-YES or (202) 775-6650 phone
(202) 233-9575 fax

TESTING CONDITIONS FOR ENERGY STAR MEASUREMENT
PERSONAL COMPUTERS AND MONITORS
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In order to eliminate confusion and ensure consistency, the following protocol should be followed when measuring power for PCs and monitors under the ENERGY STAR Office Equipment Program.

Ideally, EPA would like to keep the testing procedure as simple as possible. However, there are some tricky issues surrounding power measurement for personal computers and monitors, and these make the testing process more complex.

Outlined below are the ambient test conditions which should be established when performing the power measurement. These are necessary in order to ensure that outside factors do not affect the test results, and that test results can be reproduced later. A description of the specifications for testing equipment, as well as a discussion of testing issues, follow on the succeeding pages.

I. TEST CONDITIONS

Line Impedance:	< 0.25 ohm
Total Harmonic Distortion: (Voltage)	< 5%
Input AC Voltage:[1]	115 VAC RMS +/- 5V RMS
Input AC Frequency:[1]	60 Hz +/- 3 Hz
Ambient Temperature:	25 deg. C +/- 3 deg. C

II. TESTING EQUIPMENT

The goal is to accurately measure the TRUE power consumption[2] of the PC or monitor. This necessitates the use of a True RMS Watt-Meter. There are many watt-meters to choose from, but manufacturers will need to exercise care in selecting an appropriate model. The following factors should be considered when purchasing a meter and setting up the actual test.

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[1] If products will be sold in Europe or Asia, testing should also be performed at the appropriate machine-rated voltage and frequency. For example, products destined for European markets might be tested at 230 V and 50 Hz.

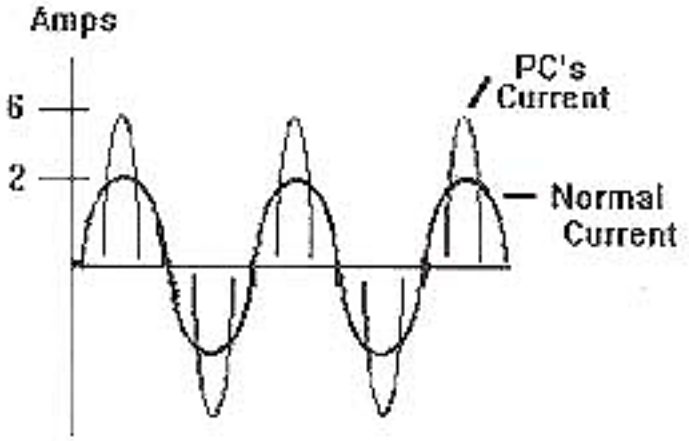
[2] True power is defined as (volts)x(amps)x(power factor), and is typically reported as Watts. Apparent Power is defined as (volts)x(amps) and is usually expressed in terms of VA or volt-amps. The power factor for equipment with switching power supplies is always less than 1.0, so true power is always less than apparent power.

Crest Factor

A previous version of EPA's testing procedure included a requirement that manufacturers utilize a watt-meter with a crest factor greater than 8. As many Partners pointed out, this is not a useful or relevant requirement. The following paragraphs are meant to discuss the issues relating to crest factor and to clarify the intent of the initial incorrect statement. Unfortunately, in order to remedy this error, EPA cannot provide a specific equipment requirement. Testing is as much art as it is science, and manufacturers and testers will have to exercise judgement, and draw on people well versed in testing issues, to select an appropriate meter.

To begin, it is important to understand that PCs and monitors which contain switching power supplies draw current in a waveform different from typical sinusoidal current.[3] Figure 1 shows the typical current waveform for a PC. While virtually any watt-meter can measure a standard current waveform, it is more difficult to select a watt meter when irregular current waveforms are involved.

Figure 1



It is critical that the watt-meter selected be capable of reading the current drawn by the PC or monitor without causing internal peak distortion (i.e., clipping off the top of the current wave). This requires a review of the meter's crest factor,[4] and of the current ranges available on the meter. Better meters will have higher crest factors, and more choices of current ranges.

When preparing the test, the first step should be to determine the peak current (amps) associated with the PC or monitor being measured. This can be accomplished using an oscilloscope. Then a current range must be selected that will enable the meter to register the peak current. Specifically, the full scale value of the current range selected multiplied by the crest factor of the meter (for current) must be greater than the peak current reading from the oscilloscope. For example, if a watt meter has a crest factor of 4, and the current range is set on 3 amps, the meter can register current spikes of up to 12 amps. If measured peak current is only 6 amps, the meter would be satisfactory. The other concern to be aware of is that if the current range is set too high in order to register peak current, it may lose accuracy in measuring the non-peak current. Therefore, some delicate balancing is necessary. Again, with more current range choices and higher crest factors you will get better results.

Frequency Response

Another issue to consider when selecting a watt-meter is the frequency response rating of the meter. Electronic equipment that contains switching power supplies causes harmonics (odd harmonics typically up to the 21st).

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[3] The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with a PC or monitor containing a switching power supply will always be greater than 1.4 (though typically no higher than 8). The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps).

[4] The crest factor of a watt meter is often provided for both current and voltage. For current it is the ratio of the peak current to the RMS current in a specific current range. When only one crest factor is given, it is usually for current. An average True RMS Wattmeter has a crest factor in the range of 2:1 to 6:1.

These harmonics must be accounted for in power measurement, or the Wattage consumption will be inaccurate. Accordingly, EPA recommends that manufacturers purchase watt-meters that have a frequency response of at least 3 kHz. This will account for harmonics up to the 50th, and is recommended by IEC 555.

Resolution
Manufacturers will probably want a meter than can provide resolution of 0.1 W.

Accuracy
Another feature to consider is the resulting accuracy you will be able to achieve. Catalogues and specification sheets for watt-meters typically provide information on the accuracy of power readings that can be achieved at different range settings. If you are measuring a product that is very close to 30 W, you will need to set up a test that will provide greater accuracy. For example, if the resulting accuracy for your watt-meter at the test settings is ± 0.5 W, then with a measured power consumption of 29.5 W you can be fairly sure that your PC or monitor is compliant.

Calibration
Watt meters should be calibrated every year to maintain their accuracy.

QUESTIONS AND ANSWERS REGARDING TESTING PROCEDURES FOR ENERGY STAR COMPUTERS AND MONITORS

Q: Where can I find a True RMS watt-meter that will meet my requirements?

A: A true RMS watt meter can be ordered from several manufacturers. The EEM catalogue lists about 75 companies under Meters, Watt. Probably only a third of these companies make meters suitable for ENERGY STAR measurement. Some manufacturers that carry watt-meters that may be appropriate include: AMEC, Clarke-Hess, NGI-Norma, Ohio Semitronic, Valhalla, Voltech, and Yokogawa. When you call any of these manufacturers be sure to tell them what you need the equipment for, and request their specification sheets. (As companies find adequate meters, please let me know so I can share them with other Partners.)

Q: Can I send my PC or monitor to an outside laboratory for testing?

A: Yes. It is also possible to send your PCs/monitors/printers/fax machines to an outside testing lab for measurement. You can make the decision to buy your own equipment, or pay to have it tested depending on the number of models you plan to test. Be sure to tell any lab about your accuracy requirements. A good test lab will be aware of the issues surrounding the power measurement for electronic devices such as PCs or monitors, but don't assume this is the case. You will probably want to give them copies of the EPA ENERGY STAR testing procedure and equipment requirements.

Q: Can I assume that the voltage coming out of my wall socket is close to 115 V?

A: No. The voltage coming out the wall could easily vary by more than +/- 5 V from the suggested 115 Volts AC. By applying a "resonant" line voltage regulator between the wall outlet and the device under test, the input voltage can be regulated to 115 V $\pm$ 1%.

Q: Will the voltage coming out of the wall have a harmonic distortion <5%?

A: Not always. However, a "resonant" line voltage regulator will help to regulate distortion to within 3%.

Q: Are these testing requirements mandatory?

A: Stringency in testing is to your own advantage. It can help protect you from being accused of cheating by one of your competitors. However, the stringency and accuracy of your own testing can be determined based on your specific product. For example, if your product does not contain a switching power supply, some of the issues discussed are not relevant, and a more straightforward testing protocol could be used. Also, if you know your product is well below 30 W, then you do not need to be as accurate in your measurement. If your product is closer to 30 W, however, it is better to follow these guidelines.